Defining the coupled effects of cryogenic, space-radiation, and hypervelocity impact damamge on COPV's, Phase II

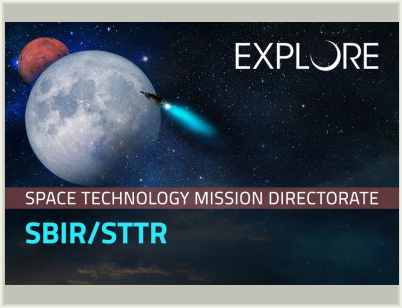
Completed Technology Project (2007 - 2008)

Project Introduction

The intent of the proposed effort is to investigate the detailed composite overwrapped pressure vessel (COPV) performance characteristics after being subject to irradiation, hypervelocity micro-meteor impact, and cryogenic environments. This will result in a safer, more reliable design for high performance COPVs. This intent will be achieved via empirical characterization of composite raw materials subsequent to exposure of the aforementioned environments. Phase I of this effort (NASA contract #NNM06AA56C) demonstrated a significant reduction in structural performance following exposure to various combinations of the aforementioned environments. This reduction in structural performance would seriously compromise the structural performance of any composite structure to be utilized in deep space applications. The data proposed in this effort would be extremely useful to NASA in what might be used in the upcoming CEV and CONSTELLATION missions. The aerospace and the commercial communities have shown significant interest in using filament wound COPVs for cryogenic applications. In addition there is serious consideration for using COPVs in deep space exploration which would sustain significant radiation exposure and possible impact damage. Constituent raw materials and existing COPV designs have not been characterized for the coupled effects of these applications and as such the safety margins for these applications are undefined. Therefore, the reliability of such usage is unknown.

Anticipated Benefits

Non-NASA commercial applications for the research proposed would include the following: LH2 fuel cell. HEI is currently executing a contract for LH2 storage for a vehicle application. This research will aid the mobile fuel cell industry safety and reliability. Vehicular CNG storage. The research proposed herein will aid the safety and reliability of the CNG vehicle market. Marine-transport of propane. The research proposed herein will develop knowledge and data applicable to transporting propane in tanker ships. Environmentally-friendly earth-based cryogenic fluid storage. Composite structures do not react to environmental corrosion as do the typical cost efficient metals such as steel. Safer earth-based cryogenic fluid storage. Due to the high strength of composite materials, little raw material is required to perform draconian structural feats when compared to typical cost efficient metals. Therefore, the manufacturing and movement of large COPVs is much less expensive and much safer. NASA applications for the research proposed herein would include the following: Cost efficient cryogenic storage vessels. These vessels could be utilized as both earth-based and space-based cryogenic storage vessels. Habitat structures. The research proposed herein is applicable to space-based habitat and other structures manufactured with fiber-reinforced composite material. Volumetric efficient cryogenic storage vessels. HEI's high pressure storage systems are highly volumetric efficient. Reliable, long system life cryogenic storage. HEI have successfully designed, manufactured, and cycle



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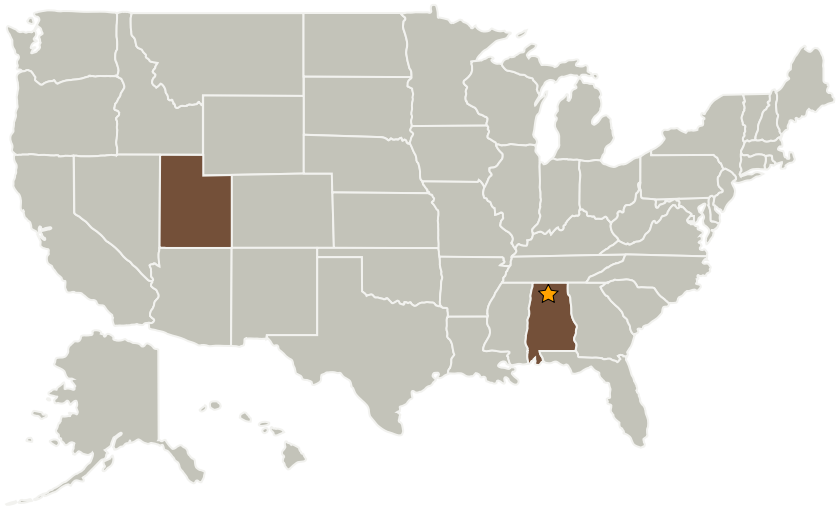
tested COPVs with up to 20,000 cycles. Space-based cryogenic COPVs. It is probable that COPVs utilized in space will experience impact damage due to micrometeoroids and other space debris and it is certain that the COPVs will experience radiation damage. The research proposed herein will assist the COPV designer by identifying the coupled effects of hypervelocity impact damage, cryogenic temperatures, and irradiation thus developing mechanical property allowables for the designer.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
HyPerComp Engineering, Inc.	Supporting Organization	Industry	Brigham City, Utah

Primary U.S. Work Locations	
Alabama	Utah

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

Brett H Smith

Principal Investigator:

Ryan Noorda

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.1 In-space Propellant Storage & Utilization